CENTRAL CALIFORNIA AIR QUALITY RESEARCH

# What are the sources of ozone? What does the science tell us about potential control strategies?

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# We already heard that ...

Oxides of Nitrogen + Reactive Organic Gases

Solar Radiation

Ozone + Other Pollutants

Ozone is a secondary pollutant formed in the atmosphere due to chemical reactions

# Contents

- Sources of ozone precursors
- Determination of the limiting precursor(s)
- Introduction to photochemical modeling
- Model performance evaluation and usage
- Model derived limiting precursor(s)
- Corroboration of model predictions
- Work in progress

# Sources of ozone precursors

- Anthropogenic precursors
  - Oxides of Nitrogen (NOx)
    - transportation, industry, etc.
  - Reactive Organic Gases (ROG)
    - transportation, solvent evaporation, consumer products, etc.
- Biogenic precursors
  - Oxides of Nitrogen
    - soil bacterial activity
  - Reactive Organic Gases
    - plant emissions

# Emissions Distribution

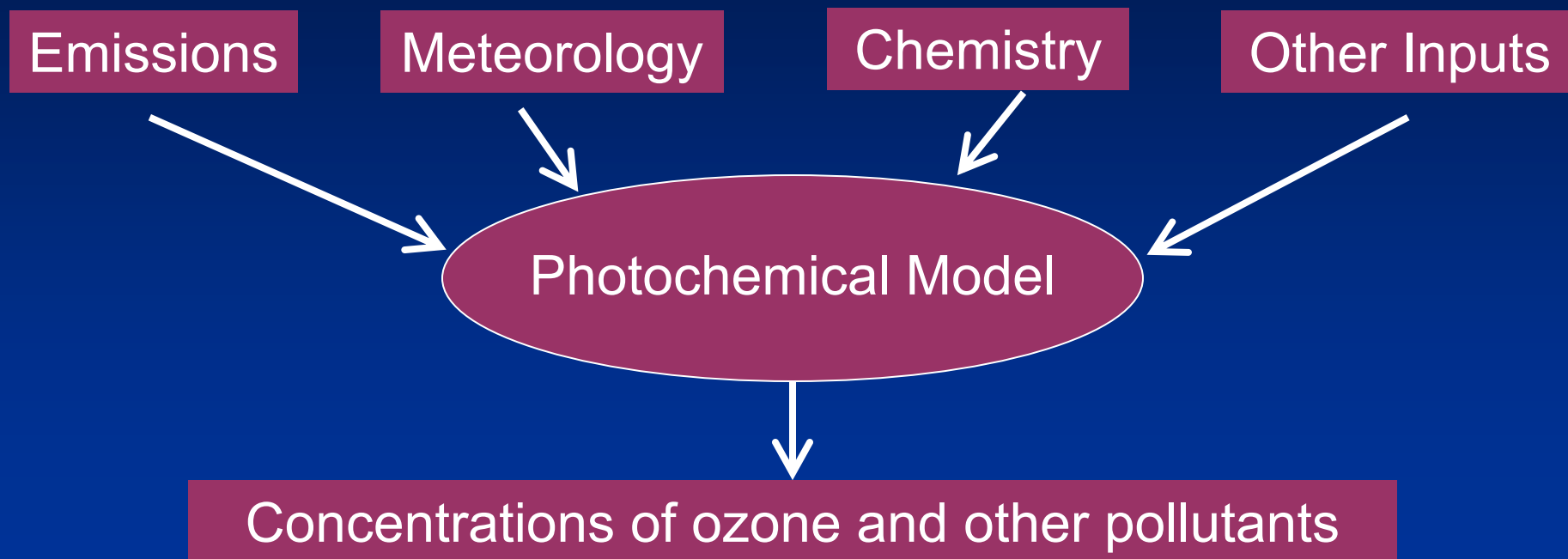## Oxides of Nitrogen

## Reactive Organic Gases
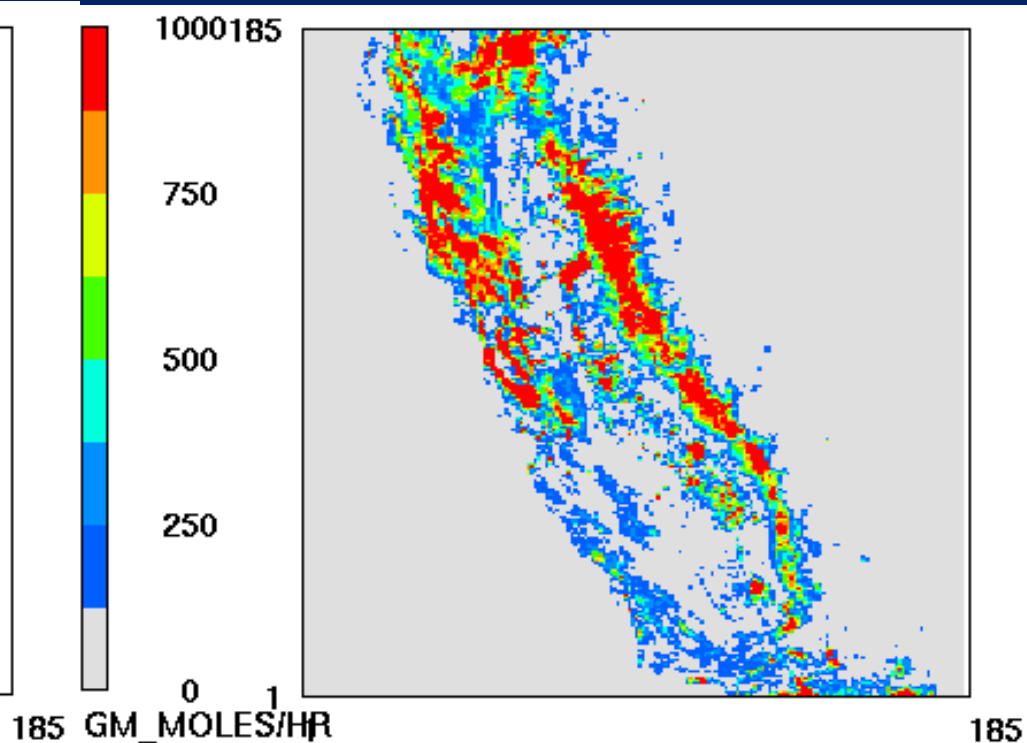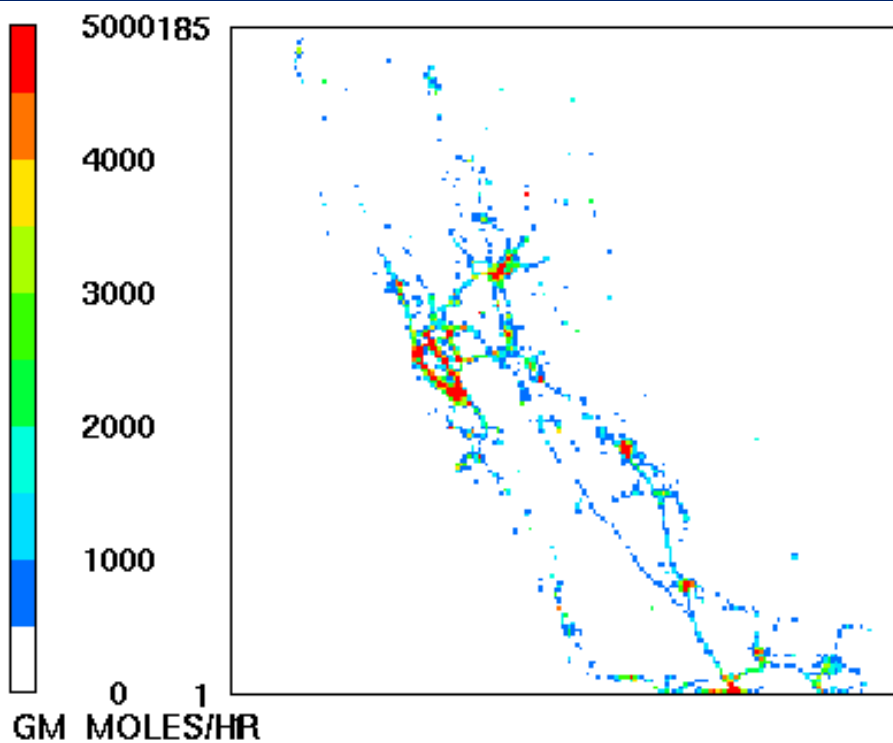


July 31, 2000 at 4:00 pm

# Determination of limiting precursors

- Observational (Qualitative):
  - Robust dataset from field studies to test observational indicators
  - Ratios of measured quantities such as ozone, NOx, ROG, and carbon monoxide
  - Weekday/Weekend effect (Several hypotheses, not tested extensively in SJV)
- Modeling (Quantitative):
  - State-of-the-science emission, meteorological, and photochemical models
  - Detailed data from field studies to apply and validate models

# Photochemical modeling

Emissions

Meteorology

Chemistry

Other Inputs

Photochemical Model

Concentrations of ozone and other pollutants

Models are mathematical representations of our best knowledge about atmospheric processes

# Modeled Ozone Distribution
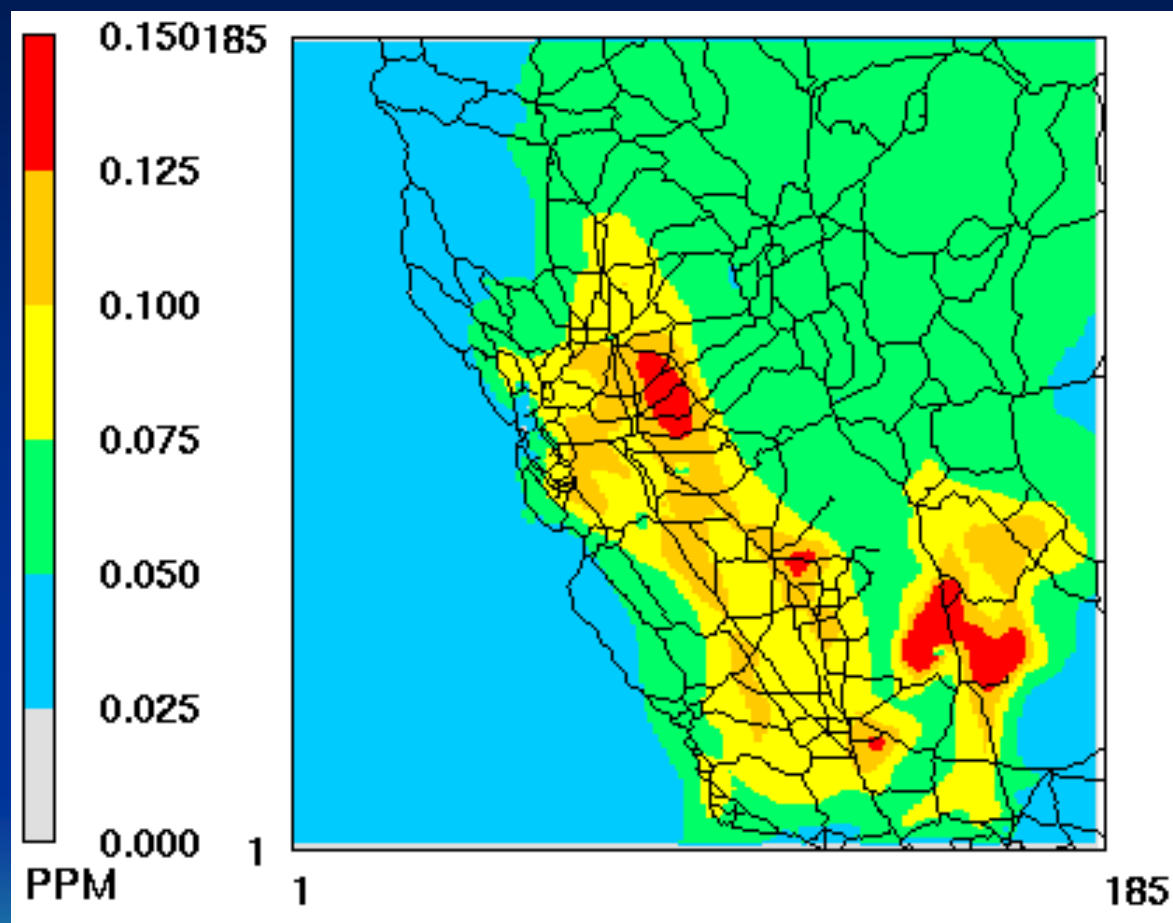


July 31, 2000 at 4:00 pm

# Model Performance and Usage

- Model performance is assessed using available measurements and standard statistical performance metrics

- Diagnostic and other evaluations to test the science of the model are also carried out

- A validated model can be used to:
  - Answer "what if" questions
  - Quantify efficacy of the limiting precursor(s)

# Comparison with Observations



**Fresno - First Street**  July 31 – August 2, 2000
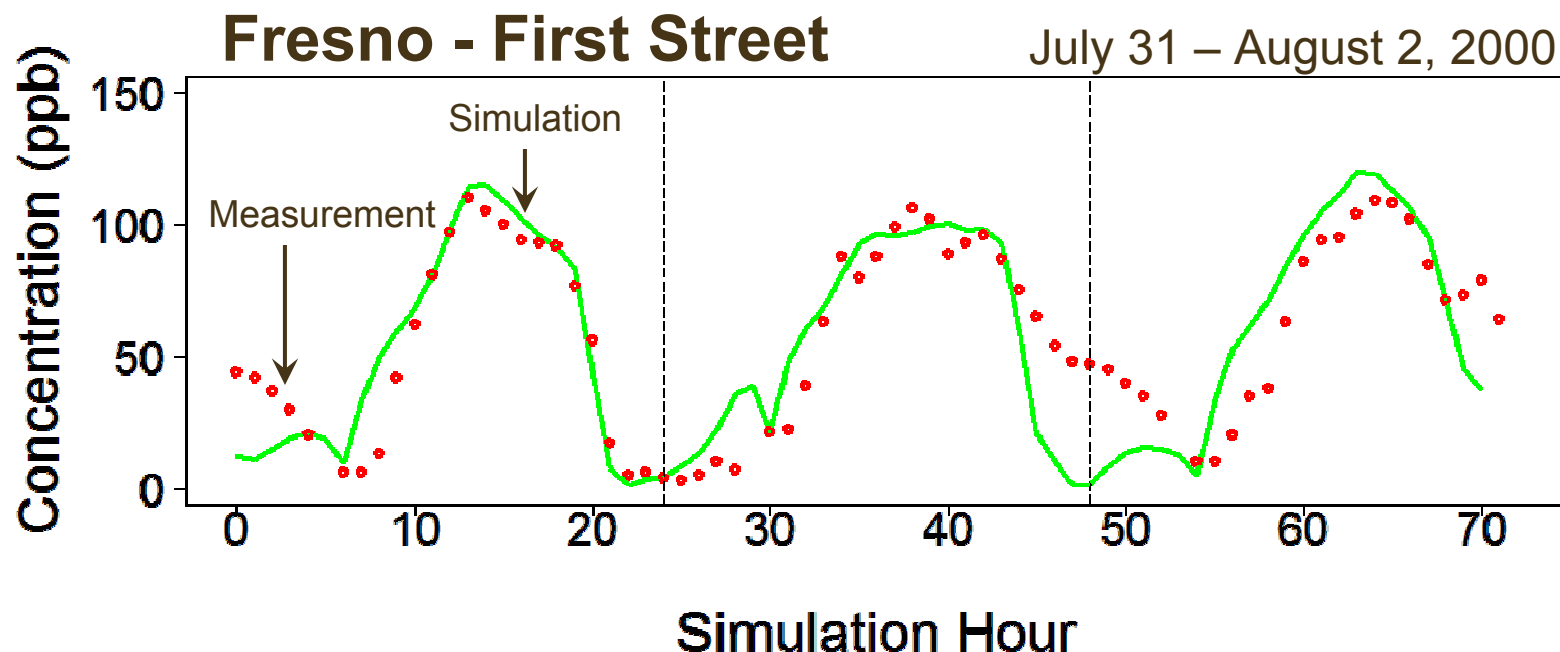
A model should reproduce the measurements to the extent possible within model assumptions

# Example "What If" Questions

- What if we implemented controls selectively?
  - one source category
  - one geographical area
  - one season
  - one precursor

A validated model is a test bed to evaluate efficacy of potential emissions control strategies

# Limiting Precursor(s) for the 1-Hour Standard

- ROG controls are more beneficial than that of NOx for the SFBA

- NOx controls are generally more beneficial than that of ROG for the Sacramento region

- In SJV, the sensitivity changes depending on the location

- As we controlled ROG and NOx, the limiting precursor(s) relationships have become more complex

# Corroboration of model predictions

- Model predictions need to be supported, on balance, by findings from data analyses
- USEPA has recommended several analyses using air-quality, meteorology, and emissions data (trends, indicator ratios, etc.)
- New corroboration methods are needed

Model results should generally agree with the findings from data analyses

# Work in progress

- Improvements to emissions (ARB, STI)
- Improved methods for meteorological modeling (NOAA, ARB)
- Improvements to chemical mechanisms (ARB, UCD, UCR)
- Evaluation of aloft model performance (STI)
- Modeling of an entire summer (UCB, ARB)
- Use of satellite products for model inputs and evaluation (ARB, USEPA, NASA, UCB)
- Further corroboration of modeled results (ARB)

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  - Sacramento Metropolitan Air Quality Management District (SMAQMD)
  - San Joaquin Valley Air Pollution Control District (SJVAPCD)
  - Tennessee Valley Authority (TVA)
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  - Georgia Institute of Technology (GIT)
  - University of California at Berkeley (UCB)
  - University of California at Davis (UCD)
  - University of California at San Diego (UCSD)
  - University of California at Riverside (UCR)

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  - Aerosol Dynamics, Inc.
  - Alpine Geophysics (AG)
  - Atmospheric and Environmental Research Inc. (AER)
  - Biospherics Research Corporation
  - Envair
  - ENSR
  - Environ International Corporation
  - Sonoma Technology Inc. (STI)
  - Technical and Business Systems (T&BS)

and many others ….